June 1, 1943. A. A. STEIN 2,320,672

MACHINE FOR GRINDING CURVED SURFACES

Filed Nov. 25, 1940 3 Sheets-Sheet 1

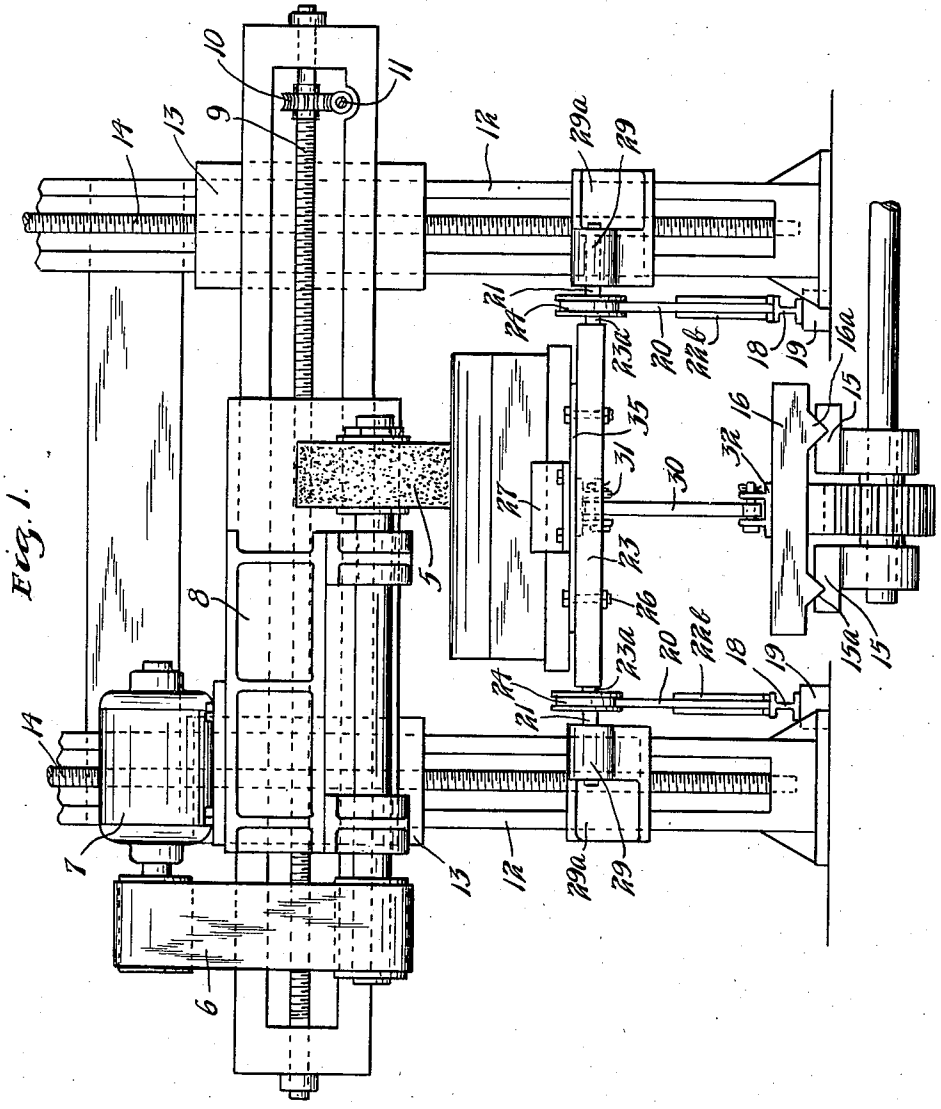


Fig. 1.

INVENTOR.
ALBERT A. STEIN.
BY HIS ATTORNEYS.
Williamson & Williamson

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Fig. 2.

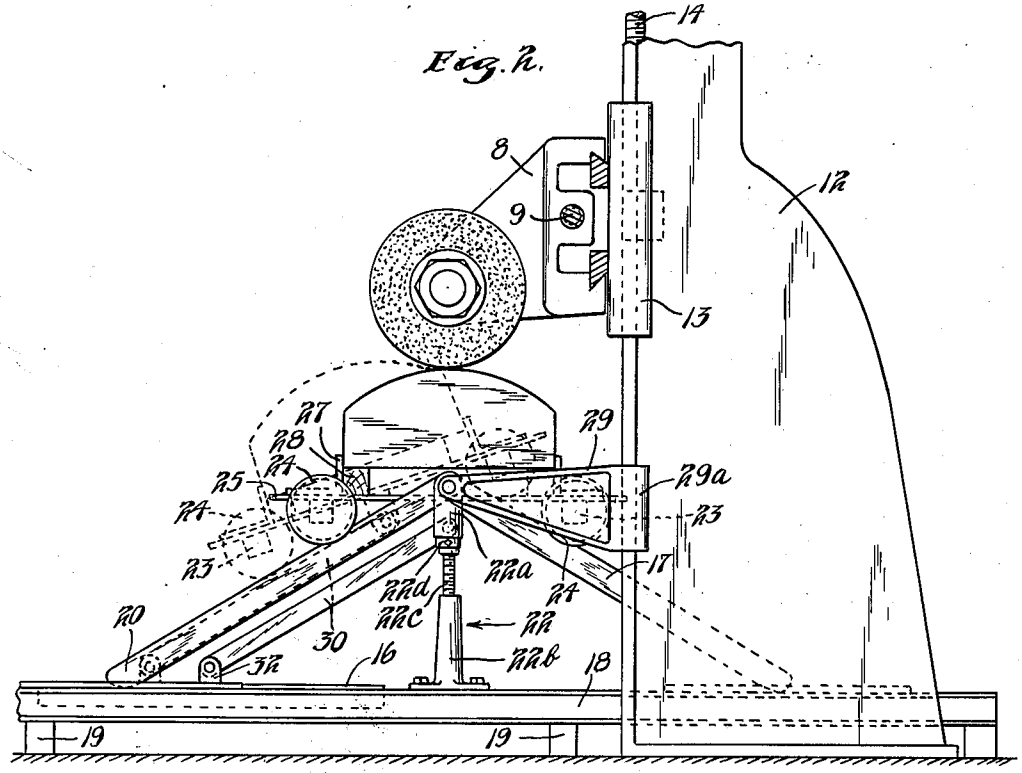
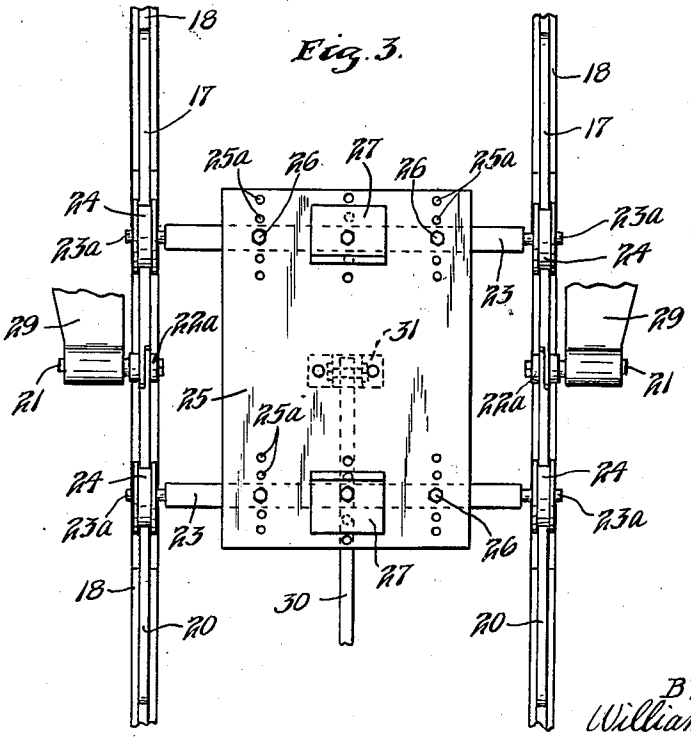


Fig. 3.



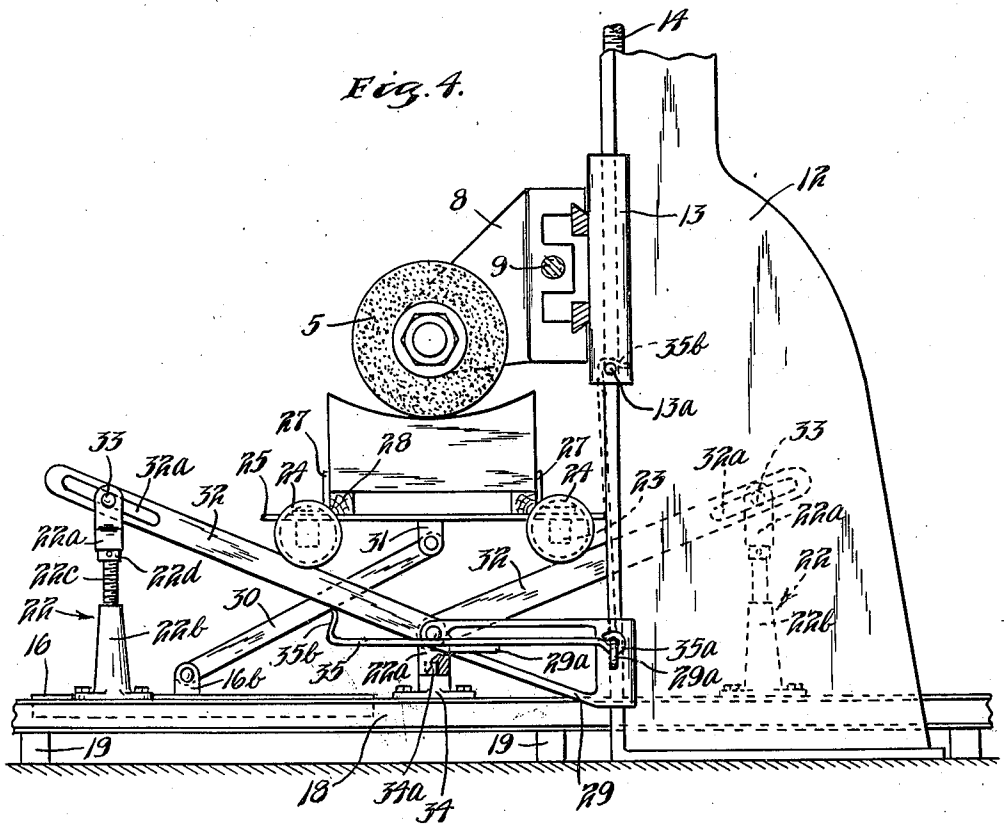
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Fig. 4.



INVENTOR.
ALBERT A. STEIN.
BY HIS ATTORNEYS.
Williamson & Williamson

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MACHINE FOR GRINDING CURVED SURFACES

Albert A. Stein, Cold Spring, Minn., assignor to Cold Spring Granite Company, Cold Spring, Minn., a corporation of Minnesota

Application November 25, 1940, Serial No. 366,983

6 Claims. (Cl. 51—46)

This invention relates to machines for grinding slabs of material, and particularly to a machine for grinding a curved or partial cylindrical surface.

It is an object of my invention to provide a simple and highly efficient machine for grinding the face of a work piece to either a convex or concave contour as the work piece is moved back and forth below the grinding or cutting element through a substantially arcuate path.

A further object is the provision of a device for moving and guiding a work piece against a grinding or cutting element in such manner as to produce either a convex or concave surface on the piece through the movement of a work-piece-supporting truck on straight track sections which produce a resultant arcuate movement of a certain point on the piece below the grinding or cutting element.

More specifically, it is an object to provide in combination with conventional types of grinding and cutting elements, a pair of oppositely inclined truck-supporting track sections set up to converge toward their adjacent or adjoining ends and disposed below the grinding element, and a truck mounted on wheels or equivalent track-engaging-supporting elements at each of its ends thereof adapted to hold a piece of work against and below the grinding element, and means of reciprocating the truck on the track through a limited movement wherein the wheels or other truck-supporting elements at the front and rear of the truck are each moved over only a portion of one section of the track to cause a curved or partial cylindrical surface to be ground upon the work piece. Convex surfaces may be ground when the tracks are set up with the sections inclining upwardly to a vertex at the connection of the two sections, and conversely concave surfaces may be ground when the tracks are set up with the two sections declining from their outer ends to their inner connected ends.

It is a still further object to provide in apparatus or in a machine of the class described, means for adjusting the inclination of the respective track sections to enable curved surfaces varying widely in radius to be cut or ground.

Still another object is to provide in apparatus of the class described a work piece moving and guiding device which may be successfully combined with conventional grinders and work-reciprocating tables now extensively used in the grinding of various stones and metals to produce smooth and uniformly ground curved surfaces.

These and other objects and advantages of the invention will more fully appear from the following description made in connection with the accompanying drawings, wherein like reference characters refer to similar parts throughout the views, and in which:

Fig. 1 is an end elevation showing an embodiment of my invention set up for grinding a convex surface wherein the rotary grinding mechanism and reciprocating table utilized are of conventional types;

Fig. 2 is a side elevation of the same, showing in dotted lines the truck and work piece in the topmost or horizontal position of the truck;

Fig. 3 is a top plan view of the same with some portions broken away, and

Fig. 4 is a side elevation of an embodiment of my invention set up for grinding a concave surface on the work piece.

In the embodiments of the invention illustrated, the conventional grinding apparatus for grinding flat surfaces is utilized including the vertically adjustable rotary grinder and the bed and slidable table for supporting a flat work piece as well as the columns for supporting the adjustable grinder. Such grinding apparatus is extensively utilized in the prepared stone industry such as the granite and marble industries.

As shown, conventional rotary grinding mechanism is utilized having the usual rotary grinding wheel **5** driven by suitable means such as a belt **6** which is trained about the driving pulley of an electrical motor **7**. The grinding wheel **5** is mounted in a slidable carriage **8** of conventional structure for reciprocating movement as it is rotated back and forth across the upper surface of a piece of work. The reciprocating of carriage **8** with the rotary grinding wheel mounted thereon is effected in conventional manner by an elongated screw **9** driven from a source of power, not shown, and having at its outer end a worm gear **10** which is meshed with a worm **11** connected with the source of rotary power. The source of power, of course, must be reversible and manually or automatically controlled in the conventional manner to cause the desired reciprocation of the grinding wheel.

The conventional grinding mechanism described is adjustably supported at its end portions on a pair of heavy upright columns **12** by means of heavy adjustable mountings **13** which may be vertically adjusted and maintained in a desired elevated position by means of the heavy, elongated, vertical adjustment screws **14** connected (not shown) with a suitable source of controlled power.

The structure previously described is all conventional, and further detailed description is thought unnecessary, it being essential that the grinding wheel is mounted on the horizontal axis extending transversely of the supporting columns and preferably that the grinding mechanism utilized is of the reciprocating type to enable the grinding stone to be moved back and forth during rotation over the upper face of the work piece.

The conventional grinding apparatus of the type described usually includes adjacent the floor line or base of support for the upright columns 12, a heavy bed comprising a pair of parallel, spaced supporting and guide-way forming members 15 extending perpendicularly to the axis of the grinding wheel 5 and usually disposed midway between supporting columns 12. The upper surfaces of the members 15 are in a common plane and are provided with V-shaped guide-ways 15a in which a reciprocating table 16 is slidably mounted. Table 16 has a pair of depending, longitudinally extending ribs 16a of V-shape which slidably engage the grooves 15a of the bed. This conventional bed and reciprocating table construction may be utilized, as will be later shown, to reciprocate my improved work piece supporting truck, although, of course, any other suitable means may be provided for producing the reciprocation of said truck.

To grind a convex or partial cylindrical surface on a work piece I provide in cooperation and combination with the grinding apparatus previously described, simple but highly efficient apparatus for guiding and holding the work piece. This apparatus includes two sections of tracks inclined oppositely and converging at their upper ends toward a point disposed below the grinding wheel. As shown (Fig. 2), one of the track sections comprises a pair of widely spaced rails 17 having their outer and lower ends free, but engaged in and abutting spaced, horizontal, channeled beams 18 which are suitably supported as by heavy cross beams 19 above the level of the table bed 15. The second track section comprises spaced parallel tracks 20, the outer ends of which are free and slidably engage the channeled beams 18, said track sections 17 and 20 being inclined to the horizontal and converging at their upper ends, said upper ends being pivotally connected together by heavy, horizontal pivot bolts 21 which are supported from and connected with the heads or upper members 22a of adjustable jacks 22. Any suitable supporting means other than a jack, preferably adjustable, may of course be utilized to support the pivotally connected upper ends of the track sections, one being supplied for each of the tracks formed by sections 17 and 20.

The jacks 22, as shown, have their bases 22b rigidly connected with the respective channeled beams 18 and are provided with the usual vertical screws 22c threadedly engaging the bases and swivelly carrying at their upper ends the heads 22a. At the upper ends of the screws 22c tool-engaging recesses 22d are provided to facilitate adjustment of the jacks. The heads of the jacks 22 are aligned and are disposed preferably in alignment with the axis of grinding wheel 5.

A truck is mounted on the track sections 17 and 20 for supporting and guiding a work piece against and beneath the rotary grinding wheel 5, and, as shown, this truck comprises a pair of spaced axle bolsters 23 terminating in axles 23a upon which supporting wheels 24 are journaled. One set of said wheels engage and are supported from the rails 17 of one of the track sections, while the other set of wheels 23 engage the rails 20 of the other track section. A work piece supporting platform 25 is supported from the axle bolsters 23 and adjustably secured thereto by means of vertical nutted bolts 26. A series of apertures 25a are disposed longitudinally through the platform 25 for each of the bolts 26 to permit the spaced relation of the axle bolsters to be varied within considerable range. Clamping devices in the form of large angle plates 27 are adjustably secured to the end portions of platform 25 for engaging the work piece and clamping the same, as shown in Fig. 2. Supporting means such as wooden beams 28 or the like may also be utilized to vary the height of the work piece above the platform 25. A rigid spacing or bracing arm 29 is mounted for vertical adjustment by means of a heavy slide mounting 29a on each of the columns 12 having in each instance its outer end connected with one of the heavy pivot pins 21 which pivotally connects together the upper ends of the respective tracks 17 and 20. The mountings 29a work in suitable guides provided by the columns 12 and may have means for clamping the mountings to the column, although this is not necessary.

As shown, the work piece truck is connected for reciprocation with the reciprocating slidable table 16. An elongated pitman 30 is pivoted at its upper end to a depending U-shaped bracket 31 secured to the center of truck platform 25, and has its lower end pivotally connected with an upstanding, similarly shaped bracket 16b secured to the top of reciprocating table 16. The pitman 30 is of such length that operative connections may be made between the table 16 and truck in the various adjusted or elevated positions of the track sections 17 and 20.

Operation—Convex grinding

In use the jacks 22 and spacer arms 29 are adjusted vertically to obtain reciprocating movement of the truck through an arc of the desired radius. The rail sections are supported and held against longitudinal displacement by their connection with the heads 22a of jacks 22, and the engagement, of course, of the free ends of the rails with the channeled beams 18 and with the jacks, support the truck thereon. The work piece is then centrally secured to the truck and, if necessary, elevated above the platform 25 of the truck by means of blocks, slabs or other means 28 of appropriate thickness. The upper surface of the work piece is usually roughly contoured to approximately the arcuate sectional shape desired, although a flat surface may be ground down by successive downward adjustment of the grinding wheel. The grinder is then adjusted through its supporting mountings in proper position for the grinding wheel to engage the top surface of the work piece. In the form of grinder illustrated, the wheel is rotated at high speed and its mounting is reciprocated transversely of the work piece through the reversible worm device 9. The work piece-supporting truck is reciprocated below the grinding wheel by its connection with the sliding table 16, and this reciprocation or movement of the truck is controlled so that the front wheels never move past the apex of the joined track sections 17 and 20 and so that likewise the rear wheels do not move past said apex. The reciprocating movement of the truck over the upwardly converging track sections 17 and 20 results in an arcuate reciprocating movement of the work piece below the grinding wheel 5. Thus,

a uniform and substantial partial cylindrical surface is ground upon the work piece, and arcs varying widely in radius may be obtained by the proper adjustment in angulation of track sections 17 and 20 through adjustment of the jacks 22 and subsequent adjustment of the grinding mechanism for engagement of the grinding wheel with the work piece. In such adjustments it is often necessary to also adjust the spaced relationship of the axle bolsters 23 of the truck relatively to the center of the truck, which is provided for by the removable bolts 26 and the bolt-receiving apertures 25a formed in the truck platform.

The horizontal spacing arms 29 assist in vertically aligning the pivotal joints of the track sections 17 and 20 with the axis of the grinding wheel 5, and further assure the vertical positioning of the jacks 22 at all times.

Fig. 4 illustrates my apparatus as set up for grinding a concave surface. The embodiment of the invention illustrated in said Fig. 4 includes a few additional parts and some differences in structure relative to the embodiment previously described and illustrated in Figs. 1 and 2. In Fig. 4 track sections comprising the two sets of rails 32 differ slightly in construction from the rails 17 shown in Figs. 1 to 3. The rails 32 are better adapted for grinding both concave and convex surfaces on a work piece and to this end are provided at their outer portions with longitudinal slots 32a adapted to adjustably receive the connecting bolts 33 connected with the heads 22a of supporting jacks when the track sections are set up, as shown in Fig. 4, with their connected ends converging downwardly to a point disposed below the grinding wheel 5. The bases of the two sets of supporting jacks 22 for the outer ends of the track sections are detachably secured to the two heavy base beams 18, the two sets being spaced preferably equi-distant from the vertical projection of the axis of grinding stone 5.

When concave surfaces are to be ground the central supporting jack is dispensed with, with the exception of its head 22a which telescopes over and receives an upstanding centering and supporting stud 34a carried by a heavy detachable plate 34 secured to the base beam 18. Horizontal spacer arm 29 is, of course, disposed in lowered position on the supporting columns 12 and embraces the coupling of the two oppositely inclined rails 32. The four supporting jacks 22 connected with the outer ends of the track sections are adjusted to incline the track sections properly to produce a convex arc of the desired radius or the desired curve on the work piece carried by the reciprocating truck.

With the track sections set up as described and as shown in Fig. 4, and with the grinder mechanism adjusted at the proper height, the work piece-supporting truck is reciprocated through its connection by a pitman 30 with the reciprocating table 16 and the work piece is moved through an arcuate path tangential to the grinding wheel 5, resulting in the grinding of a concave surface. The track sections comprising the two sets of rails 32 may be adjusted at various angulations and when oppositely inclined at the same angle to the horizontal cause a partially cylindrical concave surface to be ground while variance in the angulation of the two track sections will be effective in producing other than arcuate concave curves on the upper surface of the work piece.

The same track sections 32 may be efficiently utilized for grinding a convex surface by disconnection of the outer ends of rails 32 with the outer jacks and removal of said jacks and by securing two of said jacks 22 centrally below the grinding stone with the disconnectible heads 22a attached to the upwardly projecting studs at the top of the screws 22c. To facilitate elevation of the heavy spacer arms 29 and their sliding brackets 29a and lifting of the joined ends of the track sections, I provide, as shown in Fig. 4, elongated hook rods 35 which may be conveniently pivoted at points 35a to the outer sides of brackets 29a and which are provided with hooks 35b at their free ends for engaging studs 13a projecting laterally from the lower portions of the grinder supporting brackets 13 When hook rods 35 are connected, as shown in Fig. 4, the elevation of the grinder mechanism on the heavy columns 12 lifts in unison spacer arms 29, central jack heads 22a and the pivotal connection bolts 21, coupling the joined tracks of the two track sections. When the hook rods 35 are not connected with the adjustable supporting brackets 13 for the grinder, they may be conveniently disposed in horizontal position supported on a shelf-like web 29b formed in the exterior face of heavy spacer arms 29.

From the foregoing description it will be seen that I have provided a comparatively simple and highly efficient machine for grinding the face of a work piece to a convex or concave and substantially partial cylindrical contour. Curves departing from the arc can be obtained by inclining the two track sections at different angulations to the horizontal, which may be accomplished by lengthening the tracks of one section or by supporting the free ends of one section of the tracks at a higher elevation than the supports for the outer ends of the opposite section.

It will further be seen that I have provided a highly efficient work piece moving and guiding device which may be successfully combined with and as an attachment to conventional grinding apparatus now extensively used in the stone production industries.

The word "track," as appearing hereafter in the appended claims, is used, of course, in its broad sense to define any supporting surface or elements upon which wheels or other slidable or rotating supporting means are supported and guided.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts without departing from the scope of my invention, which generally stated, consists in a device capable of carrying out the objects above set forth and in the novel parts and combinations of parts disclosed and defined in the appended claims.

What is claimed is:

1. A device for moving and guiding a piece of work beneath a grinding mechanism to produce curved surfaces comprising, a pair of oppositely inclined track sections converging toward a point below said grinding mechanism, means for supporting said track sections at various inclinations to the horizontal, a work-supporting truck having truck-supporting, track-engaging means at the opposite ends thereof, each of said truck-supporting means engaging one of said track sections for travel thereover, means on said truck including a plane supporting surface and clamping means for holding a piece of relatively thick solid material to be ground, and means for reciprocating said truck on said inclined track sections.

2. A device for moving and guiding a piece of work beneath a grinding mechanism to produce curved surfaces, comprising, a pair of oppositely inclined track sections converging toward their adjacent ends, means for connecting the adjacent ends of said track sections with freedom for angular adjustment of said sections, a vertically adjustable support for said last mentioned means, a work-supporting truck having track-engaging-supporting means at the opposite ends thereof, each of said last mentioned means engaging one of said track sections for travel thereover, means on said truck for holding a piece of work to be ground, and means for reciprocating said truck on said inclined track sections.

3. In a machine for grinding a convex surface, an elevated rotary grinding wheel, a guiding track disposed below said grinding wheel, said track comprising two oppositely inclined sections converging upwardly toward a point below said grinding wheel, means for connecting the upper ends of said sections together for variance in the angulations thereof, means for supporting the lower ends of said track sections, vertically adjustable means for supporting said means connecting said track sections, a work-supporting truck having track-engaging means at the opposite ends thereof supported respectively on said two track sections, and means for reciprocating said truck on said inclined track sections.

4. In a machine for producing convex surfaces by grinding action, an elevated rotary grinding wheel, a guiding track disposed below said grinding wheel, said track comprising two oppositely inclined sections converging toward a point below said grinding wheel, means for connecting the adjacent ends of said track sections, said connection means being permissive of variance in the angulations of said sections, vertical adjustable means for supporting said connecting means, a base for supporting the outer ends of said sections, said outer ends being free for adjustment in the angulation of said sections upon variance in the height of said supporting means.

5. In a machine for producing curved surfaces, an elevated rotary grinding wheel, a guiding track disposed below said grinding wheel, said track comprising two oppositely inclined, straight sections converging toward a point below said grinding wheel, a work piece guiding truck having track-engaging-supporting elements at both ends thereof, said truck having work-holding means at the upper portion thereof provided with a substantially plane surface and clamping means for holding a relatively thick block of material to be ground, said elements being respectively supported on the two oppositely inclined sections of said track, work piece supporting means on said truck, means for reciprocating said truck on the adjacent portions of said track sections with a piece of work engaging said grinding wheel to produce a curved surface on said work piece, and readily adjustable means for varying the angulations of said inclined track sections to vary the shape of the curved surface produced.

6. In a machine for producing concave and convex surfaces, an elevated rotary grinding wheel, a guiding track disposed below said grinding wheel, said track comprising two oppositely inclined, straight sections converging toward a point below said grinding wheel, a work-supporting truck having a set of wheels engaging one of said track sections and having another set of wheels spaced from said first mentioned set and engaging the other of said track sections, said truck having a plane-supporting floor and having clamping means adjacent the ends thereof for securing a solid block of material to be ground, means for supporting said track below said grinding wheel, and means associated with said last mentioned means for varying the angulations of said track sections.

ALBERT A. STEIN.